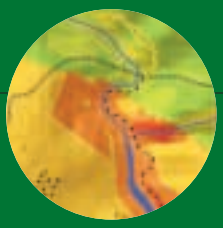
6 Science for Parks



"Although an adequate science program alone cannot ensure the integrity of the national parks, it can enable faster identification of problems, greater understanding of causes and effects, and better insights about the prevention, mitigation, and management of problems."

National Research Council

Stewardship of the vast array of resources in the national parks is a tremendously important and increasingly exacting responsibility for the National Park Service. Spread out over 85 million acres (34 million ha) in 388 units located in 49 states and 4 territories, park resources are incredibly diverse and dynamic. Ensuring their well-being amid global, regional, and local environmental forces of change and providing for their enjoyment by the roughly 275 million annual visitors to the national parks require sound management based on scientific information. As the articles in this chapter illustrate, science and collaborative scientific partnerships are addressing a wide variety of information needs and aiding park management decision making. Ecological information detailing the presence, distribution, sensitivity, and condition of park resources is helping managers to protect, restore, and recover natural systems. Sociological information about park visitors, such as their opinions about natural resource protection and their preferences for park interpretive information, is helping staff of the National Park Service become better stewards and public servants. Economic information, too, is being used to prioritize and plan resource management activities. Though the following articles highlight but a small portion of the scientific applications to park management for 2004, they are indicative of a healthy attitude toward park science for the future that includes collaboration, innovation, and dedication.

Assessing riparian system recovery at Santa Rosa Island, Channel Islands National Park

By Joel Wagner, Kate Roney Faulkner, Sarah Chaney, and Michael Martin

IN 1995 THE STATE OF CALIFORNIA DIRECTED managers at Channel Islands National Park to correct water quality problems on Santa Rosa Island caused by year-round grazing of approximately 5,000 cattle. Authority for regulating water quality in the park is delegated to the state in accordance with the federal Clean Water Act. To respond, park managers needed a rapid evaluation of riparian conditions on the island; they also wanted to know if changes to existing livestock management would help achieve water quality goals. A multiagency, interdisciplinary team decided to use the Bureau of Land Management's (BLM) "Process for Assessing Proper Functioning Condition" (PFC) to evaluate 10 stream reaches in seven of the island's watersheds. Three of the 10 reaches were "reference reaches" that were largely or completely inaccessible to cattle, while the other 7 were subject to year-round cattle grazing.

Investigators completed fieldwork for the initial assessment in March 1995. Of the seven stream reaches that were subject to year-round cattle grazing, six were "nonfunctional" and one was rated "functional at risk." Of the three reference reaches, two were in "proper functioning condition" and one was rated "functional at risk." In nonfunctional systems, an oversupply of sediment from upland and channel sources had exceeded the streams' transport capability, resulting in mostly braided channel forms, high lateral instability, and other characteristics that were out of balance with the landscape setting. In addition, riparian-wetland vegetation was almost completely absent, exposing banks to excessive erosion in each flood event.

The National Park Service eliminated cattle from the island in 1998 and substantially reduced deer numbers. Riparian vegetation cover and water quality then dramatically improved. In 2004, park managers requested assistance from the NPS Water Resources Division to perform postgrazing riparian reassessments on the island. In order to evaluate and document vegetative and geomorphic changes, investigators reapplied the same (PFC) method and took repeat photographs on the stream reaches that were assessed in 1995. The main inquiry was: by removing cattle, had riparian areas that were "nonfunctional" in 1995 returned to "proper functioning condition," or were additional management steps necessary for recovery?

All six reaches that were rated nonfunctional in 1995 regained proper functioning condition.

The 2004 team found that all six reaches that were rated nonfunctional in 1995 regained proper functioning condition. Sediment-choked, braided channels evident in 1995 have progressed to narrower, deeper, meandering channels with well-developed floodplains that are in balance with the landscape setting. Herbaceous riparian-wetland vegetation that was nonexistent in 1995 now covers more than 90% of the area along most of these reaches. However, the expected woody riparian components (willows and cottonwoods) have not reestablished. Although willows and cottonwoods may not be absolutely necessary for bank and floodplain stabilization in these

In just six years since cattle grazing was discontinued, Arlington Canyon on Santa Rosa Island has been transformed from a nonvegetated, braided stream channel considered "nonfunctional" (left) to one with appropriate riparian-wetland vegetation, and evaluated in 2004 as functioning properly (right). The change was documented by resource managers who repeated an appraisal process to determine stream condition that they had first applied in 1995. In the 1995 photo (left), excess sediment derived from the overgrazed watershed and nonvegetated stream banks fills the channel and degrades water quality. In the 2004 photo (right), sediment deposits have created a functional floodplain, and the narrower, meandering channel has improved water quality and aquatic habitat characteristics.

The BLM "Process for Assessing Proper Functioning Condition" *is a rapid assessment of riparian function according to 17 hydrology, vegetation, and stream geomorphology factors. Ratings include "proper functioning condition," "functional at risk," and "nonfunctional." The proper functioning condition of a riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A riparian system in proper functioning condition is in dynamic equilibrium with its streamflow forces and channel processes. The system adjusts to handle larger runoff events with limited change in channel characteristics and associated riparian-wetland plant communities. Because of this stability, properly functioning riparian areas can maintain water quality, fish and wildlife habitat, and other important ecosystem functions even after large storms. In contrast, nonfunctional systems in the same storms might exhibit excessive erosion and sediment loading, loss of fish habitat, and loss of associated wetland habitat.*

reaches, they would enhance such stability, help dissipate flood energy, and provide valuable wildlife habitat that likely occurred historically in the canyons. Hence, the 2004 team identified management actions (including planting willow and cottonwood) that would put the recovering riparian systems on a trajectory toward desired future conditions.

The remarkable improvement in Santa Rosa Island's riparian conditions since 1995 demonstrates these systems' abilities to restore themselves once the major stressor—year-round cattle grazing—is removed. The transition from nonfunctional to properly functioning riparian systems became possible when vegetation recovery in the watersheds led to decreased runoff and sediment delivery to the island's stream systems and when appropriate riparian-wetland vegetation became established. ■

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Search for aquatic invasive species in Mississippi and Gulf Islands National Seashore

By James M. Long

Fishery biologist Jim Long sorts and identifies a sample of fish that was captured as part of the rapid assessment.

Rapid assessment is a quick and intensive inventory of species and evaluation of ecological conditions that often involves tens or hundreds of scientists investigating an area of management concern. It is an efficient way to describe baseline conditions and is an especially valuable tool for recording the presence and extent of invasive species. In August 2004 the National Park Service at the Mississippi unit of Gulf Islands National Seashore teamed up with AMRAT (Alabama-Mississippi Rapid Assessment Team), a multiagency consortium, to conduct a rapid assessment of the Mississippi Sound.

Twenty-nine agencies involving 116 individuals participated in the weeklong study. Team members pulled seines through nearshore areas, lagoons, and ponds to collect plants and animals. They scraped bridge pilings for attached invertebrates, combed the beach, and examined terrestrial plant communities. They also trawled the bottom and mid-depth areas of the ocean, electrofished upper estuaries, sampled oyster beds, and trapped crabs. As investigators in the field collected specimens and recorded notes, a team at the Gulf Coast Research Laboratory sorted and identified the samples that were being brought in.

Though the plant data are still being processed, the assessment documented 330 animal species. Most (109) were fish, but the samples also included 95 crustaceans, 54 mollusks, and 31 annelids or segmented worms. Two invasive species were discovered: the Asian clam (*Corbicula fluminea*) and the Nile tilapia (*Oreochromis niloticus*). The Asian clam has been known to take over aquatic systems, whereas impacts from the escapement of Nile tilapia, a species introduced from Africa to the United States for food production, into natural systems are not known. These data will eventually be housed in a geographic information system format accessible through the Gulf States Marine Fisheries Commission Web site (http://www.gsmfc.org).

With this assessment, Gulf Islands National Seashore has obtained regional species data, enabling it to compare park species lists with those of the surrounding area. In particular, this information will allow seashore managers to deal with threats of exotic aquatic species that might invade park lands. ■

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Using bat assemblages as a measure of ecosystem health

By Leslie Chow, Elizabeth Pierson, and William E. Rainey

IN 2003 THE U.S. GEOLOGICAL SURVEY and University of California–Berkeley began a three-year study to investigate patterns of bat distribution and activity in response to aquatic insect emergence and abundance in Yosemite National Park, California. Called "Project Bats and Rivers," the study is funded by the Yosemite Fund, a private, nonprofit partner of the park. Using a combination of acoustic sampling and mist (fine mesh) netting, investigators learned that the number of bat species declines as elevation increases; the number of species with reproductive populations also declines with elevation. Preliminary analyses reveal considerable night-to-night variation in activity levels at most sites. Bat activity in the summer and autumn generally correlates with ambient temperature, with the greatest activity occurring on the warmest nights. In 2004 the team made the unexpected discovery that, though activity is low on the coldest nights, insect emergence and foraging continue at temperatures near freezing. Although the Bats and Rivers project started as an investigation of bat distribution and activity, two years of fieldwork suggested that the techniques being used were also applicable to monitoring ecosystem function by detecting changes in bat assemblages (groups of bat species inhabiting specific areas).

As predators that rely almost exclusively on insects, bats may provide a reliable measure of ecosystem function.

Until recently, bats have been hard to study because they are nocturnal and capturing them in mist nets is challenging. Acoustic detection now provides a reliable technique for recording and identifying each species based on its unique echolocation calls. During the 2004 field season the team continued to modify and improve the reliability of the Anabat acoustic detection system so that it can be used for long-term monitoring. Falling prices and lower power requirements for data storage devices have allowed investigators to deploy equipment that can operate without intervention for up to three months. These devices, which turn themselves on at dusk and off at dawn, store bat calls on small memory cards. The solar-powered systems have allowed researchers to sample simultaneously at multiple locations for extended periods with minimal labor. The system automatically identifies the species and records its abundance for a given night.

The team tested the efficacy of using this equipment in July 2003 by deploying 15 detectors simultaneously at selected elevations for six to eight nights. The detector in Yosemite Valley, when downloaded in late January 2004, revealed highly unexpected results: very high levels of bat activity (rivaling levels in summer) over the river, even on nights when the temperature dropped well below freezing. To place this finding in context, there is almost no information regarding where California bats winter. Although very large aggregations hibernate in caves in the eastern and midwestern United States, very little is known about winter behavior or overwintering sites for most western species. The intense bat activity, involving at least three species, suggests that Yosemite Valley, with its combination of granite cliffs and nearby river, may serve as a significant winter refugium for bats.

Comprising the second largest order of mammals in North America, bats trail only rodents in number of species. The NPSpecies database has records for 77 species and subspecies of bats in 141 units of the National Park System, with an average of 5 species per unit. Seventeen bat species occur in Yosemite National Park, including the spotted bat (*Euderma maculatum*, juvenile shown). The park is the site of a three-year study of bat activity and overwintering habits. The study tested solar-powered Anabat acoustic detection systems to monitor winter bat activity at 15 sites in Yosemite National Park, including this one along the South Fork of the Merced River.

As predators that rely almost exclusively on insects, bats may provide a reliable measure of ecosystem function. Changes in the composition of bat species in a particular location may reflect ecosystem changes that require more intensive study. Using arrays of 8 to 10 acoustic detectors spread among a variety of habitats enables investigators to "capture" the widest diversity of bat species, increasing the chances of detecting those that are rare or habitat-specific.

The Sierra Monitoring Network is currently inventorying bats in three parks. In Sequoia National Park, two Anabat acoustic detectors are monitoring bat activity over the 2004–2005 winter. A remaining challenge for the Anabat system is developing filters that will fully automate the identification of bats from their calls. Though the Anabat acoustic detection system recognizes the sonogram of the calls of many species, some species still require visual examination of call sequences. The team is also working on designing a statistically valid sampling protocol for detecting real changes in bat assemblages. When the protocol is fully developed, assemblages of bat species could be selected as a "vital sign," an indicator of ecosystem conditions for monitoring networks where bats abound. ■

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Evaluating ecological services and replacement costs of the urban forest in our nation's capital

By Gopaul Noojibail and Brad Conway

URBAN FORESTS PROVIDE FUNDAMENTAL ecological and psychological benefits to cities and their inhabitants. Trees in urban areas act as biological machines that reduce air pollution, filter and absorb storm water, and cool temperatures. Additionally, trees give people a sense of well-being amidst a hectic urban environment.

Altogether, the National Park Service manages more than 16,000 culturally significant trees in the National Mall and Memorial Parks and at President's Park (the area around the White House) in Washington, D.C. Managing these trees for sustainability and longevity is important because many are global icons, including the American elms that line the National Mall and the delicate Japanese cherry trees that surround the tidal basin. Trees that are historical, culturally valued as memorials, given as donations, and highly visible and charismatic are major assets that can be translated into dollars in terms of their values both as capital assets (i.e., replacement costs) and ecological services (i.e., pollution removal and carbon sequestration). Moreover, because of the relatively harsh conditions of the urban environment in Washington, D.C., these trees require exceptional care.

In 2003–2004, the National Park Service partnered with the USDA Forest Service, the Casey Tree Foundation, and the University of Maryland to assess the health, diversity, and age of one of the nation's most recognizable urban forests and to assign dollar values to its capital worth and ecological services. Teams of trained technicians composed of seasonal rangers, university interns, and volunteers conducted fieldwork to collect information about the urban forest during summer 2003 and 2004. These technicians collected data on the geographic locations of all the trees, including site information; tree identification; biometric measurements (e.g., diameters at breast height, tree heights, and crown volumes); and numerical and qualitative characteristics of crown, trunk, and root deformities and conditions. Investigators inputted the data into the USDA Forest Service Urban Forest Effects (UFORE) quantitative computer model, which allowed them to quantify ecological services, forest structure, and capital asset value.

Teams collected and analyzed data on 16,238 trees, then estimated the capital asset value of the trees at more than $30 million. This is not the ecological or societal value of the forest but an estimate of tree replacement costs. Of the trees inventoried, 87% were in good to excellent condition and provided ecological services amounting to more than 8.8 million pounds (4,000 metric tons) of carbon storage with about 200,000 pounds (90 metric tons) of carbon sequestered per year. Carbon stored in trees and other plants can help mitigate atmospheric effects of carbon dioxide released into the environment by motor vehicles. The inventoried trees provide additional benefits in the form of pollution removal to the sum of 121,254 pounds (55 metric tons) of pollution removed annually, a service estimated at more than $26,000.

The National Park Service manages more than 16,000 culturally and ecologically significant trees in Washington, D.C. During summer 2003 and 2004, teams of trained technicians collected biometric data on these trees using personal data assistants (PDAs) linked to GPS units (below). Investigators used the information to quantify the trees' ecological services, forest structure, and capital asset value; NPS staff will continue to use the information for future maintenance and site planning.

Using baseline data from the inventory, resource management staff at the National Mall and Memorial Parks is developing a maintenance-based data collection tool and GIS program to better address management needs. For example, future data applications will include identifying where trees are missing in accordance with site planting plans, tracking diseases throughout the community, tracking survivorship of Dutch elm disease–resistant elm cultivars, identifying survivorship of tree species in different areas, creating a historic-tree preservation plan, and directing maintenance efforts. Staff will continually update this database with information about new tree plantings, removals, and causes of removal.

In order to track changes in the urban forest over time, teams will reassess 10% of the community every year to detect overall changes and trends, with the intention of completing a new inventory every 10 years. In addition, the tree maintenance crew will use this collection system during tree care activities, and the information will facilitate planning efforts directed at maintaining and increasing the number of healthy trees in National Park System units in our nation's capital. ■

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Sources of regional haze identified at Big Bend National Park

By John Vimont

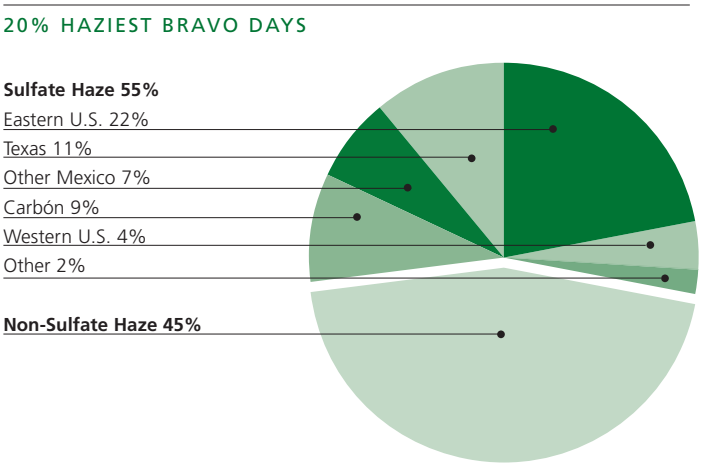
LOCATED IN SOUTHWEST TEXAS, BIG BEND is one of the few national parks where haze has been increasing since the late 1980s. Haze is caused by scattering and absorption of light (light extinction) by suspended particles in the air. Particles can stay suspended in the atmosphere for many days and can be transported for hundreds of miles. Sulfate particles are the single largest contributor to haze at Big Bend, accounting for about half of the haze on average and half on the haziest days. They form from chemical reactions of sulfur dioxide gas, which is emitted by coal-fired power plants, metal smelters, refineries, other industrial processes, and volcanoes.

During the 1990s, new coal-fired power generation, without sulfur dioxide pollution controls, was developed at the Carbón facilities near Piedras Negras, Mexico, 130 miles (209 km) east-southeast of Big Bend. The associated increase in emissions raised concerns about Carbón's contribution to sulfate and haze levels at the park. To determine the causes of haze at Big Bend, the National Park Service and the U.S. Environmental Protection Agency carried out the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study in 1999, with participation by the Texas Commission on Environmental Quality and the Electric Power Research Institute. The Mexican government took part in the planning stages of the study, but declined to do so in the field measurement, data analysis, and modeling efforts. The long duration of the BRAVO analysis period was due to an ambitious consensus-building, stakeholder process with an emphasis on scientific peer review.

The BRAVO study included four months of intensive monitoring from July through October 1999, followed by extensive data analysis and modeling. Field measurements and subsequent laboratory analyses determined the concentrations and chemical composition of the atmospheric particles and the concentrations of unique tracer compounds that were released at four locations to assess particle transport. A number of methods were used to ascertain which source regions were contributing to the sulfate haze at Big Bend. Some involved examining the relationships among different measured chemical components and tracer compounds, while others were based on numerical models of the meteorology, pollutant transport, and chemical reactions of the atmosphere. One notable aspect of the BRAVO study was the innovative way in which numerical atmospheric modeling was reconciled with the measured chemical compounds to give a more accurate assessment of the contributors to sulfate haze.

The results of the study were published in 2004 and can be downloaded from http://www2.nature.nps.gov/air/studies/bravo/index.htm. A short sampling of the findings follows:

- On average, during the study period more than half of the sulfate at Big Bend National Park came from the United States, particularly the eastern region and Texas.
- On average, Mexican sources contributed about a third of the total sulfate; about a fifth of the total came from the Carbón I and II power plants.
- Eastern U.S. and eastern Texas sources were the largest contributors to peak particulate sulfate episodes.
- Airflow from eastern Texas and the eastern United States is most frequent in late summer and early fall when sulfate contributes most to haze.
- Mexico and the western United States were the largest contributors on the least hazy days of the study, which were frequently associated with air transport from the western United States.



The pie chart summarizes the estimated contributions of particulate sulfate by source region to haze levels at Big Bend National Park for the 20% haziest days of the BRAVO study period. Here, haze is expressed in terms of light extinction, which is the fraction of light lost from a sight path per unit of distance. The units used here are "inverse megameters" (1/Mm). Particulate haze of 56 1/Mm corresponds to a visual range of 37 mi (59 km).

For the future, sulfur dioxide emission reductions generally should help reverse the trend of worsening visibility in the Big Bend region. This is particularly true of sources in Texas and the eastern United States, given the significance of their contribution to haze. Reductions in these emissions from the western United States and northern Mexico would help maintain and improve the least hazy days.

Current and pending federal regulations should help reduce these emissions throughout the United States and make significant progress toward improving visibility in Big Bend National Park. Although sources in Mexico also contribute to visibility impairment at Big Bend, U.S. regulations have no effect in Mexico. Partnerships between agencies in Mexico and the United States to address transport of pollution might be of use in the Big Bend region. ■

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Resource management specialist caps career with precedent-setting projects

Some people have a talent for stirring things up. Others have the skill to smooth troubled waters. Occasionally, both attributes can be found in the same individual. Such is the case with **Carroll Schell**, recipient of the 2003 Director's Award for Natural Resource Management, given in spring 2004. Throughout his 34-year career with the National Park Service, Carroll initiated and participated in a variety of innovative resource management projects that will have lasting impact on the agency and the resources under his care. "I believe very strongly that when you surround yourself with quality staff, they make you look good. And, frankly, I was surrounded by the best," Carroll says. "Consider, for example, that in 14 years we introduced red wolves (attempt was unsuccessful), otters, barn-owls, native southern Appalachian brook trout to streams formerly occupied by exotic rainbow trout, and elk. But it wouldn't have happened if my staff wasn't driven by a cause. I did all I could to make sure they had the resources and tools to do their job.… And it worked."

As the supervisory natural resource management specialist at Great Smoky Mountains National Park, Tennessee and North Carolina, for 14 years prior to his retirement in 2004, Carroll Schell supervised an ongoing stream of projects related to air and water quality, vegetation, fisheries, and wildlife, many of which set new standards for Park Service resource management activities. As an example, the Tapoco project for relicensing four dams operating near the park challenged Carroll to work collaboratively with multiple partners through complex legal issues. He emerged as a conciliatory force that brought divergent interests together in a spirit of compromise to the benefit of all concerned. In resolving violations of federal legislation in the decades-old agreements, the project will create a land corridor for wildlife that links Great Smoky Mountains National Park with adjacent national forests and will create a fund from which about $100,000 will be available annually for natural resource projects along the corridor.

Carroll's successful and significant strides in natural resource management also speak to his ability to cultivate human resources. As Student Conservation Association (SCA) coordinator, Carroll employed more SCA workers at Great Smoky Mountains National Park in 2003 and 2004 than did any other federal agency. In 2003 alone, the Volunteers in Parks program under his coordination compiled 30,559 hours of service, including the SCA hours.

Carroll Schell's career contributions represent the best of the National Park Service, bringing parks and people together in a lasting legacy of stewardship of America's natural resource heritage. ■

NPSFACT
The FY 2005 budget for the National Park Service funds an additional two vital signs monitoring networks: the Arctic Network in northwest Alaska and the Southeast Coast Network in Florida, Georgia, Alabama, and North and South Carolina. This brings **the number of funded networks to 24 (shown in green), with 8 proposed for funding in FY 2006 (gray).** Monitoring networks are designed to document the status and trends of park natural resources in support of management decision making and resource protection.

Using GIS to define resource sensitivity at Prince William Forest Park

By Paul Petersen

An ongoing challenge for resource managers is to develop methods that identify areas of special concern, or highly sensitive areas, to protect natural and cultural resources. At Prince William Forest Park, Virginia, a geographic information system (GIS) is being used to analyze resource sensitivity in order to model suitable trail routes within the park. The Sensitive Area Model (SAM) is being used to identify forest communities that are inherently sensitive. The model evaluates location and terrain of natural and cultural resources, unique habitats, rare species, historically significant areas, and areas stressed from visitor impacts. The analysis results in output of geographic data, identifying zones of higher and lower resource sensitivity and suitable for display on a map.

The 37 miles (60 km) of trails in the park make it a popular destination for hikers from the Washington, D.C., area. Continual visitor use may impact resources associated with the trail network. In winter 2004, park staff used SAM to identify suitable locations for potential trail routes and areas that should be considered highly sensitive. The model included information on trails, streams, slope, historical structures, sensitive habitats, campgrounds, picnic areas, and rare species. The output is displayed as a map with a ramped color scale, with green corresponding to low sensitivity, yellow corresponding to medium sensitivity, and red corresponding to areas of high sensitivity (see illustration).

The SAM trail model was implemented in 2004 to evaluate a 1-mile (1.6-km) reroute of the South Valley Trail. The results helped staff to adjust the route to follow a path with low sensitivity. SAM methodology has many potential applications for use in any park. Two additional SAM applications planned for Prince William Forest Park are the evaluation of potential new entrance points and the assessment of areas at high risk for exotic plant infestation. ■

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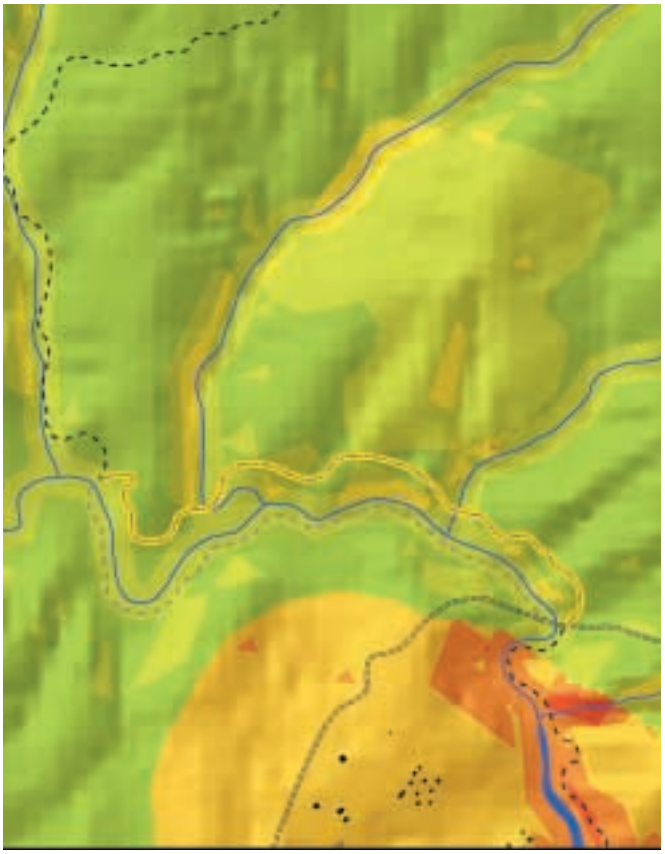
PRINCE WILLIAM FOREST PARK—CABIN CAMP 2&5 DISTRICT

SAM OUTPUT COLOR RAMP



Legend

Trail
Trail Reroute
> 25-degree Slope
Eastern White Pine
Structure
Paved Road
Unpaved Road
Hydrology

Resource Sensitivity

Low
Moderate
High

New Visitor Information System helps parks better understand visitor needs

By James Gramann and Chris Ellis

A NEW SYSTEM FOR THE ANALYSIS of national park visitation was piloted at Shenandoah National Park, Virginia, in 2004. In the past, parks have only counted the number of visitors, which gives park staff little insight into the people being served by the park and their needs. The new Visitor Information System (VIS), developed jointly by the NPS Social Science Program, the Recreational Fee Demonstration Program, and participating parks, will help park managers better understand such characteristics of park visitors as home location, racial and ethnic characteristics, and education attainment levels. This information can be used to improve park services and identify special needs.

The Visitor Information System collects data on visitors' Zip codes, countries of origin, and persons per vehicle. These data are then analyzed using census databases to create information based on what is known about people living in a particular Zip code. The project takes advantage of a fact long known to demographers and market researchers: people tend to live near people like themselves. Thus, in most cases the social and economic profile of a Zip code provides a reasonable picture of a visitor without invasion of privacy, since the information is not linked to specific individuals.

How does the Visitor Information System work on the ground? In the pilot effort, park personnel at Shenandoah began collecting information about people using park admission passes at entry points. The National Parks Pass and the Golden Age Passport (plastic version) have a magnetic strip encoded with a unique serial number that allows researchers to collect and track visitor data over time. For example, when an admission pass is swiped at a fee collection point, the data captured can be used to determine the frequency of the card's use and park travel patterns. Additionally, all visitor groups were asked for their Zip code and the number of adults and children in their vehicle. Park staff recorded this information on cash registers and the data were downloaded to a computer. Country codes were recorded for international visitors. Data were compiled periodically and sent to the Social Science Program in Washington, D.C., where additional analysis was performed. Currently, participation in the VIS program is limited to parks that use the Advantage Point of Sale fee collection system.

In March 2004, 14,080 vehicles from 3,129 unique Zip codes entered Shenandoah National Park. The red marks represent the spatial distribution of park visitors rather than visitation frequency, and each accounts for a single, unique Zip code area where visitors reside.

Park staff welcomes visitors to Shenandoah National Park, the site of a new Visitor Information System trial in 2004. Visitors' Zip codes and other data were recorded at entrance stations and later analyzed, giving managers information to help them better serve the public.

Shenandoah National Park began collecting VIS data in March 2004, with country codes added in June. By the time visitation peaked in the fall leaf-viewing season, fee collectors were highly experienced with the system. Data entry typically took 30 seconds or less per vehicle, so queuing at entrance stations was not significantly greater than normal for a peak-season visit.

What has Shenandoah learned about its visitors? First, the person-per-vehicle multipliers currently used to calculate visitation are accurate. International tourists in the period June through October accounted for 4% of park visitation, with the rest coming from the United States. From March through October, Virginia (39%), Maryland (8%), and Pennsylvania (4%) contributed the largest numbers of U.S. visitors. Nearly 5% were from three Zip codes located near the park. In these three local Zip codes, about 80% of the population 25–34 years of age were high school graduates and 12% had a bachelor's degree. Racially, communities in the three areas were predominantly white (74–93%), with a small to moderate percentage of African Americans (3.5–20%). Finally, 28–47% of each community reported an annual household income of $50,000 or more.

The information generated by the Visitor Information System can be used to improve visitor services and communication strategies, monitor trends in visitor characteristics following significant events such as wildfires or fee changes, and identify underserved populations and communities. For example, if park staff learns that many of its visitors come from a specific foreign country or ethnic group, educational material and safety information can be modified to meet these visitors' needs. Also, outreach programs can be targeted to nearby areas or groups that are underrepresented in current visitation. The Visitor Information System harnesses social science techniques developed by the private sector to meet the needs of national park visitors. ■

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Visitor use and evaluation of interpretive media: Analysis of visitor surveys

By Brian E. Forist

Park managers planning for visitor services and resource protection need accurate information on visitors, their trips to parks, how they acquire park information, and how good parks are at interpreting resources for the public. To this end the Social Science Program of the National Park Service (NPS) published the report "Visitor Use and Evaluation of Interpretive Media" in early 2004. Distributed to park and program managers, the report was based on analyses of 23 in-depth surveys of visitors to national park units in 14 states and two U.S. territories. The surveys were conducted from 1997 to 1999 by the NPS Visitor Services Project, a branch of the NPS Social Science Program based at the University of Idaho Park Studies Unit. What makes this report unusual is its comprehensive analysis and compilation of the earlier data, which until 2004 had only been analyzed on a park-by-park basis. Visitor use of nine types of interpretive media (audiovisual programs, bulletin boards, Internet/park Web sites, park brochures, park information radio stations, park newspapers, self-guided tours, visitor center exhibits, wayside exhibits) and ranger-guided programs was examined (see top graph, next page). In addition, visitor evaluation of the importance and quality of each media type was included.

Overall, park brochures were used by the greatest proportion of visitors (62%). By contrast, 22% of visitors reported participation in ranger-guided programs. Except for bulletin boards, park information radio stations, and Internet/Web sites, all other types of interpretive media were used by a greater proportion of visitors than were ranger-guided programs. (Surveys conducted by the Visitor Services Project in national parks since 1999 indicate greater use of the Internet.)

Self-guided tours were rated as the most important type of interpretive media. Only self-guided tours and park brochures were considered more important to visitors than ranger-guided programs. Audiovisual programs were assigned the highest quality rating by visitors. Ranger-guided programs were considered the highest-quality interpretive medium.

The full report is available on the Social Science Program Web site at http://www.nature.nps.gov/socialscience/docs/Visitor_Use_and_Evaluation.pdf. ■

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Understanding visitor opinions of park resources

By Margaret Littlejohn and Steve Hollenhorst, Ph.D.

Knowing how visitors view park resources is a key element in the protection of those resources. Such information helps managers determine resource quality indicators and standards, patterns of resource degradation, and public support for resource protection decisions. Because park managers simply cannot talk to all visitors, studies of visitor attitudes conducted by the NPS Visitor Services Project (VSP) are one way of getting direct, scientifically valid feedback. Since 1988 the Visitor Services Project has conducted nearly 150 visitor studies in more than 120 units of the National Park System. All past study reports, executive summaries, and surveys are available online at http://www.psu.uidaho.edu/.

How visitors value park resources has been an important part of many VSP studies. Park managers often design questions for their particular VSP visitor studies about the importance of selected resources such as clean air, scenic views, wildlife, and native plants and animals.

What resource or resource-related quality received the highest combined "extremely important" and "very important" ratings over the past 10 years? Not surprisingly, scenic views have consistently received the highest importance ratings (99%), although responses have been as low as 60%. Results for each park can easily be compared. For instance, air quality importance responses ranged from 97% at Acadia National Park (1998) to 73% at Mojave National Preserve (1997), as shown in the graph at the bottom of the next page. Ranges for other selected resources or resource-related qualities were: solitude—87% to 48%, natural quiet/sounds of nature—92% to 57%, wildlife—93% to 37%, and native plants/animals—95% to 72%.

Visitor behaviors and the intent to behave a certain way are other types of information that is valuable for resource protection. For example, do visitors care enough about park resources that they would change their behavior to help the park protect those resources? At Mount Rainier National Park, a survey was directed at visitors from Puget Sound, Washington, who were asked whether significant deterioration of the air quality at the park would be a major factor in making a decision to alter their driving habits (e.g., carpooling). More than half of visitors (61%) responded that they would be likely to change their driving habits to prevent further deterioration of air quality at Mount Rainier.

Visitor studies are an important and valuable information tool to park managers in helping them steward park resources effectively throughout the National Park System. The Visitor Services Project is working toward creating a database to allow easy comparison of data among parks and regions and to give an overall picture of visitor opinions for the National Park System. Still a few years off, this tool for comparing data will provide a wealth of information for park managers and the public. ■

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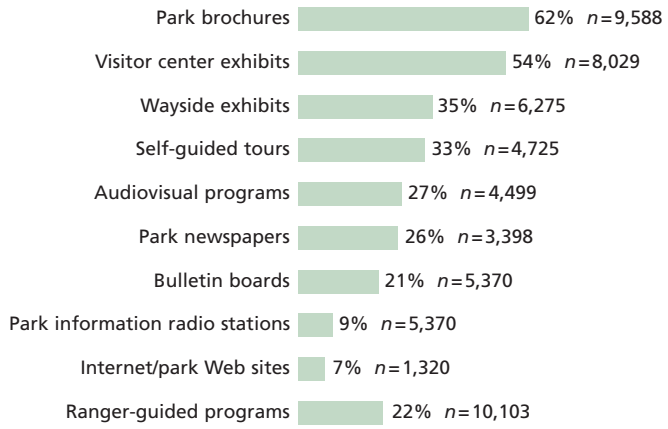
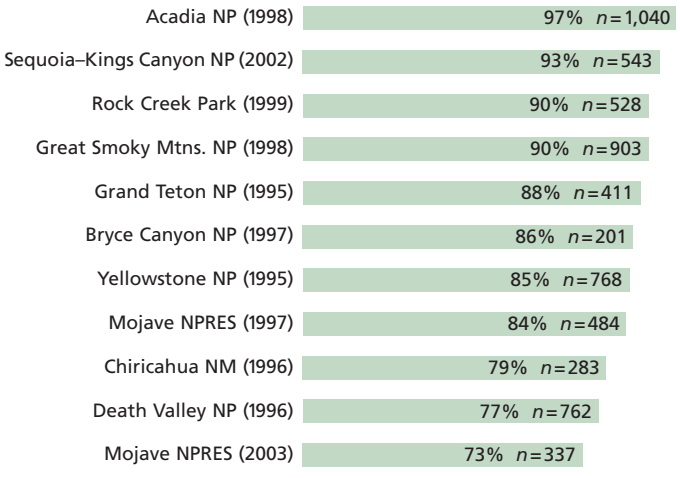
VISITOR USE OF INTERPRETIVE MEDIA



Park brochures and visitor center exhibits were used by more than half of respondents to 23 visitor surveys conducted in units of the National Park System in 1997, 1998, and 1999. Less than a quarter of visitors surveyed participated in ranger-guided programs.

VISITORS AND AIR QUALITY IMPORTANCE



The graph shows the percentage of visitors at 11 national park areas who consider air quality to be either extremely or very important.

award-winner

Coral reef biologist recognized for conservation efforts at War in the Pacific

Brimming with life and protecting land from storm surge, coral reefs surround Guam, a small U.S. territory in the Northern Mariana Islands that is closer to the Philippines and China than it is to Hawaii. Though a 1,000-acre (40-ha) area of reef is protected as part of the seven-unit War in the Pacific National Historical Park, it is nonetheless threatened by the suffocating effects of topsoil deposition caused by erosion of the island's uplands. "If you can't manage the issues on land, you can't conserve the reefs," according to **Dr. Dwayne Minton**, the park's chief of resource management and 2004 winner of the Trish Patterson–Student Conservation Association Award for Resource Management in a Small Park. Dwayne has aggressively tapped into a variety of funding sources since coming to the park as its first resource manager four years ago. In that time he has built a program of terrestrial and marine-based research and education focused on the erosion problem and reef preservation.

Dwayne laid out a five-year plan that has brought direction to resource conservation at the park. "We went through a process of identifying the resources of the park, impacts to them—where they're coming from and how severe they are—and planning for their mitigation," he says. War in the Pacific now has species lists for fish and small mammals, in addition to a plant inventory, and is on its way to establishing a resource monitoring program.

Significantly, research has linked the local practice of burning upland grasses to enhance hunting and create firebreaks with erosion of the savannah and degradation of the reef. Dwayne explains that the park's northern units offer a chance to protect the reefs because they encompass almost an entire watershed. "Because the system is interconnected, we can measure sediments that have eroded from land and deposited onto the coral reefs and try to get an idea of how much erosion is occurring."

Dwayne incorporates outreach education as part of the park's resource protection strategy. "Our goal is to help the local people see the connection between burning, erosion, damage to the reef, and a decline in the fishery, which is an important consequence to them," he says. "We are working with lots of great partners to try to make these connections evident to the people of Guam."

Given the team approach to resource management at the park, Dwayne is uncomfortable at being singled out. "I really don't like the idea of this being an individual award," he says. "It's certainly nice to have one's work be appreciated, but our program really won the award. We have a great staff that works very hard on our conservation issues, and they get the work done. They deserve a lot of credit."

For the future, Dwayne and his staff have set their sights on finding new ways to restore the savannah grassland. Exactly how to do this is not clear, he admits, as many areas are denuded of vegetation and resemble badlands. Yet, through the hard work of his talented staff and by taking a scientific approach, Dwayne has hopes for success. The reef is counting on him. ■